PH 320: Day 4

1 Superposition of Discrete Sources

The electric (or gravitational) potential due to a number of static charges (or masses) is the sum of the potentials due to the individual sources.

In order to handle multiple sources, it is necessary to replace $r$ in the potential by $|\vec{r} - \vec{r}_i|$, resulting in

$$V(\vec{r}) = \frac{1}{4\pi\epsilon_0} \frac{q}{|\vec{r} - \vec{r}_i|}$$

and its gravitational counterpart

$$\Phi(\vec{r}) = -G \frac{m}{|\vec{r} - \vec{r}_i|}$$

Recall that

$$|\vec{r} - \vec{r}_i| = \sqrt{(\vec{r} - \vec{r}_i) \cdot (\vec{r} - \vec{r}_i)}$$

and that the term under the radical sign can be multiplied out. This is just the Law of Cosines! A common convention is to use the same letter for a vector and its magnitude, an example being

$$r_i = |\vec{r}_i|$$

2 Dipoles

Today’s group activity combines the math (power series) and physics (electric potential) we’ve been discussing. All of these potentials can be approximated by appropriate power series using the methods from class — there’s no need to compute the coefficients using differentiation. But it’s important to understand the approximation process: Make sure you are expanding in terms of something small!

This requires rewriting each potential, typically to make it look like

$$(1 + \text{something small})^\text{power}$$

Furthermore, The something small must be unitless, since a power series in $z$ is nonsense if $z$ has units.

After expanding these potentials near the origin or far away, look at the leading term or two and ask yourself if they are what you expect.